Space Weather Technical Forecast

Issued on Friday, 13 September 2024 at 12:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1-G2 Minor to Moderate storms with CME arrival forecast to occur overnight day 1-2 (13-14 Sep). Further M-class flares expected, with a chance X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with peak flare M6.8 from AR3811, now over the southwest limb. This was the likely source of an extended period of above M-class flare background X-ray irradiance from 12/2140-13/0936 UTC with a relatively wide and bright CME observed from the west limb, along with a further double peaking M5.3 at 13/0655 UTC. Frequent low M-flares were also observed. There are eight regions visible, with the other region of interest AR3825, a newly numbered region that recently rotated onto the southeast limb. While modestly sized, this has some apparent complexity, although it remains hard to assess due to its near limb location. AR3814 in the northwest disc has lost some complexity, with all other regions small and simpler.

The broad CME from the southwest, along with one observed off the northwest, have been assessed as missing Earth. A likely eruptive event was also observed from near AR3814 at 13/0900 UTC. However the size of any associated flare was obscured by the on limb activity, and it remains to be seen if any CME occurred.

Solar Wind / Geomagnetic Activity: Ongoing CME effects continued at first due to the arrival on 12 Sep. Solar winds observed by ACE at L1 rose from slightly elevated at 500km/s to be briefly strong at around 600 km/s around 12/1800 UTC before erratically easing to be slightly elevated at 450km/s by the end of the period. Density was at or above average until 12/1930 UTC, then eased to mainly below. Interplanetary Magnetic Field (IMF) Bt, was initially Strong, at 20-29nT, then eased from 12/1900 UTC, gradually declining to 7nT by the end of the period. The north-south component, Bz, initially reached a strong minimum of -26nT at 12/1305 UTC before rotating to a strong maximum +18nT at 12/1546 UTC. Then rotated to be persistently negative, with initial minimum of -23nT at 12/1712 UTC, before easing back to being Weak to Moderate negative from 12/2000 UTC. Minimum before this period reached around -9nT. Phi angle was positive throughout (away from the Sun). Geomagnetic activity was G2-G3 Moderate to Strong storm 12/1200-2100UTC, then eased to G1 Minor storm 12/2100-13/0900 UTC, before easing further.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at background. High energy electron flux (greater than 2MeV) observed by GOES16 was at background The associated 24-hour fluence remained below the Active threshold, with 9.82e6 integrated pfu observed at 13/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: High to Moderate activity expected with M-class flares expected and a chance of further X-class flares, albeit decreasing as the southwest activity rotates further onto the far-side.

Solar Wind / Geomagnetic Activity: Current CME influence is expected to continue easing through today (13 Sep), before a further arrival is anticipated. This is from the M1.0 flare CME from AR3814 on the north disc at 10/2350 UTC. This is forecast to arrive either very late today, but more likely early on day 2 (14 Sep). Coronal hole fast winds could potentially arrive day 3 (15 Sep)

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

from CH68/- in the north disc before a further enhancement is possible from CH69/+ in the south disc. Unsettled to G1/Minor storm conditions will soon ease to Quiet to Active on day 1 (13 Sep), but likely followed by a further enhancement to Active to G1 Minor Storms with isolated G2 Moderate storms possible, due to the CME arrival. These most likely early on day 2 (14 Sep), before easing back to mainly Quiet to Unsettled by day 3 (15 Sep). Coronal hole influences may further increase activity for a time, to Unsettled to Active later day 3 into day 4 (15-16 Sep), and then Active to G1 Minor Storm day 4 into day 5 (16-17 Sep).

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain near background. However current activity on the southeast limb gives a chance of proton flux rising, most likely on day 1-2 (13-14 Sep), with a chance of exceeding the S1 Minor Radiation storm level. This risk receding later in the period. High energy electron flux is expected to remain mainly at Background with the associated 24 hour fluence remaining below Active.

Figure 1a: Solar Winds since 12/1200 UTC

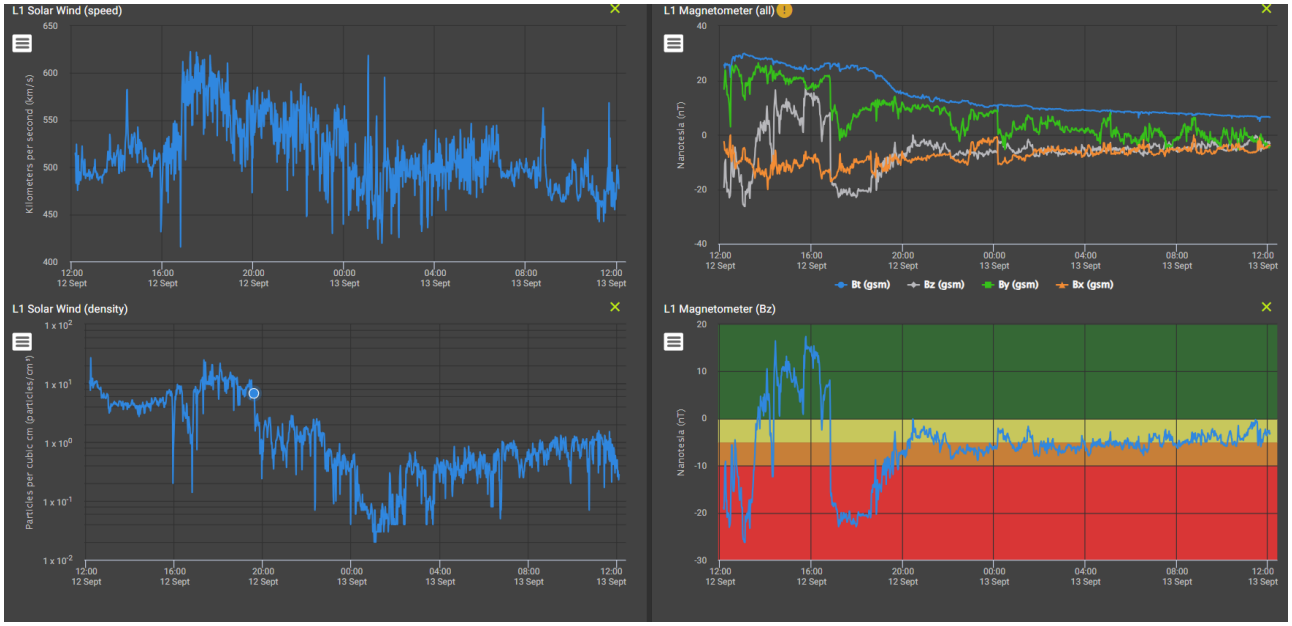
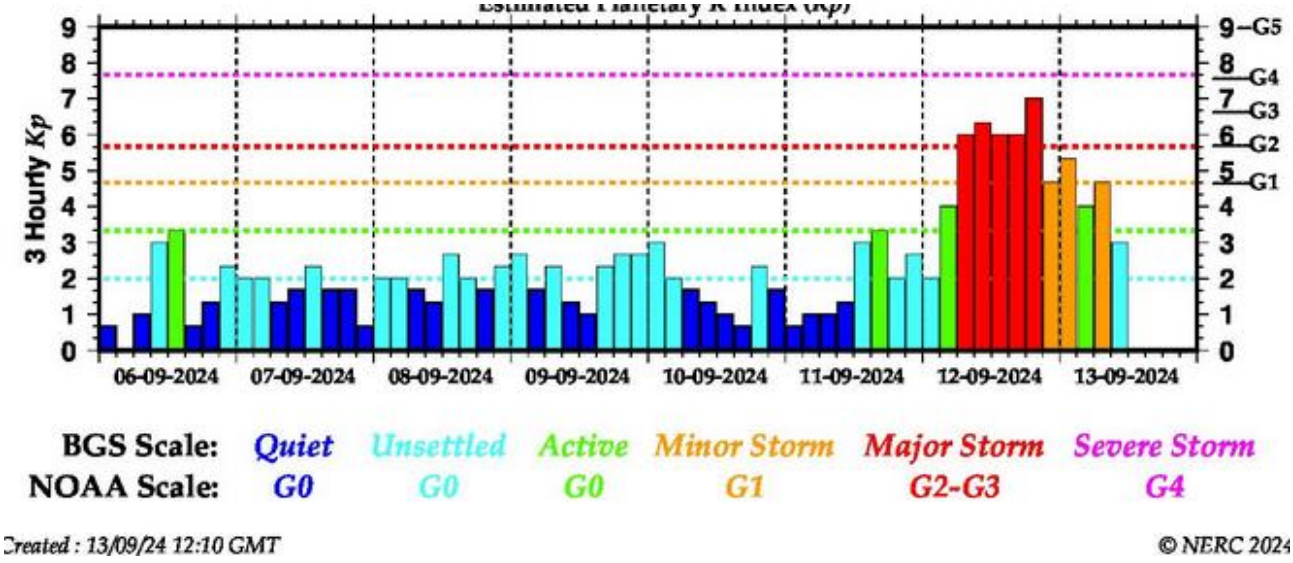


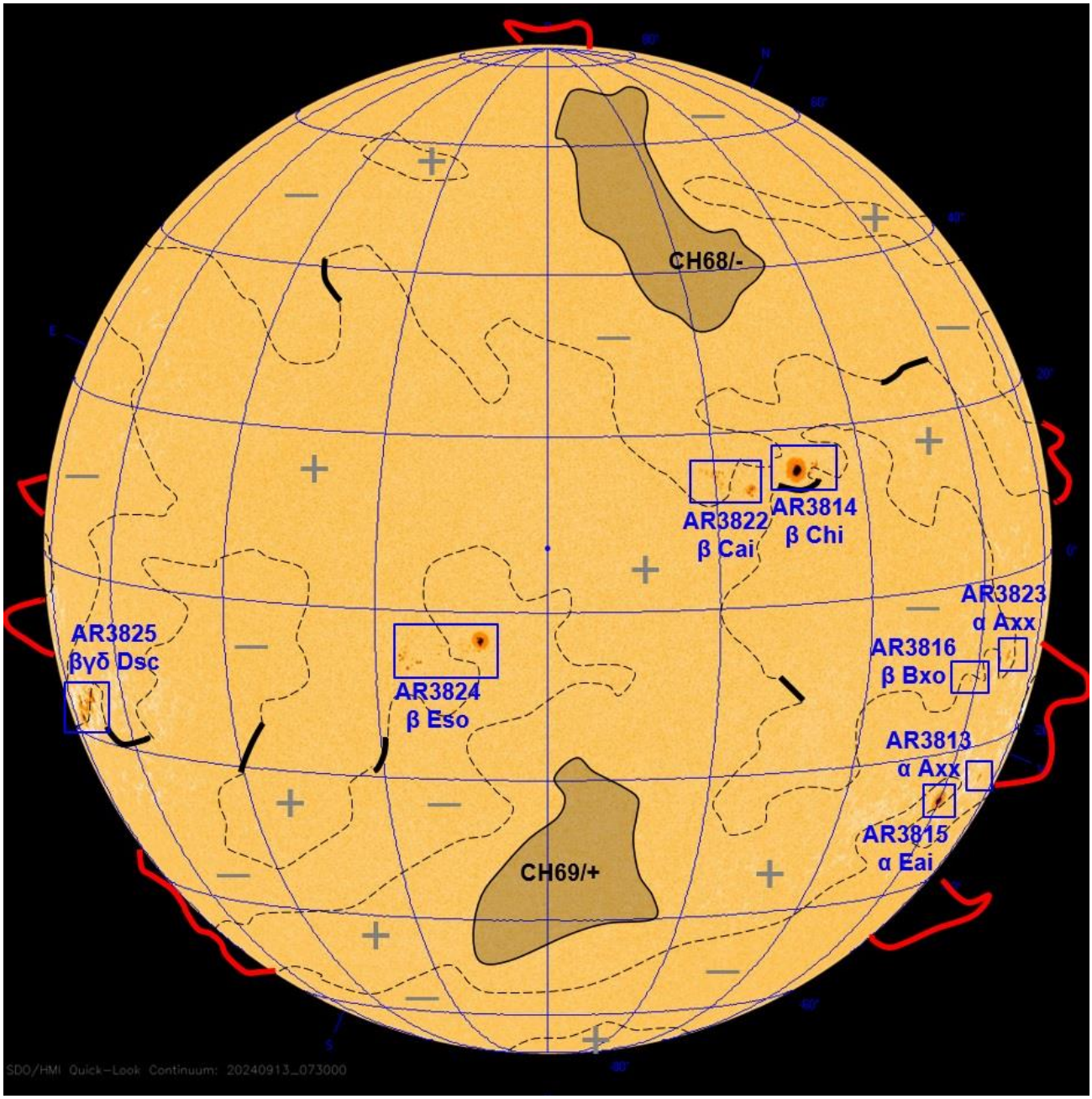
Figure 1b: BGS observed geomagnetic activity



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 1. Solar Analysis Valid 13/0800 UTC.



.

Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms:

CME arrival on 12 Sep resulted in disturbed geomagnetic conditions that are now easing. A further CME arrival is forecast overnight on 13 Sep to 14 Sep, with a most likely arrival 14/0100 UTC, but this is low confidence. This originated from the same sunspot as 12 Sep CME arrival, AR3814, from an M1.0 flares at 10/2350 UTC. This CME was slower and more diffuse however, suggesting a weaker arrival. A further potentially eruptive event occurred from AR3814 around 13/0900 UTC, although it is currently too early to assess the likelihood of any Earth-directed CME occurring.

Aside from this arrival, there are also two coronal holes which may influence the forecast. CH68/- is the most westward of these, with any high speed stream likely connecting late on day 3 (15 Sep), but is both quite far north and unfavoured for a significant connection at this time of year. CH69/+ is then most likely to connect on day 4 (16 Sep) Confidence is low however due to its southern location and Earth currently being above the solar equator. The bulk of any fast wind from this feature may subsequently pass south of Earth, as indicated on MOSWOC enlil.

Unsettled to G1 Minor storm conditions will soon ease to Quiet to Active on day 1 (13 Sep), but likely followed by a further enhancement to Active to G1 Minor Storms with isolated G2 Moderate storms possible, due to the CME arrival. These most likely early on day 2 (14 Sep), before easing back to mainly Quiet to Unsettled by day 3 (15 Sep). Coronal hole influences may further increase activity for a time, to Unsettled to Active later day 3 into day 4 (15-16 Sep), and then Active to G1 Minor Storm day 4 into day 5 (16-17 Sep).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	80	70	5	20
Strong	G3	Yes	5	10	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

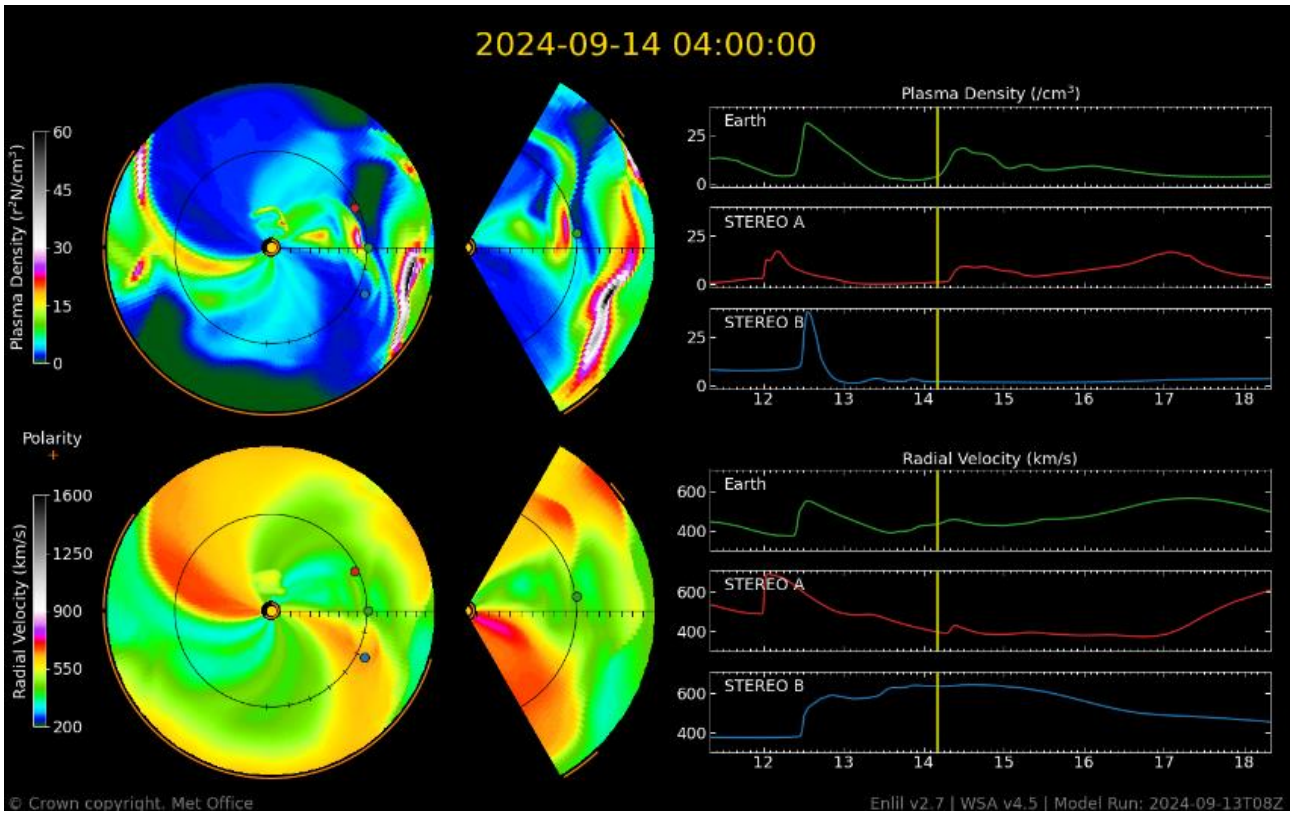
Geomagnetic Activity - Earthbound Coronal Mass Ejections

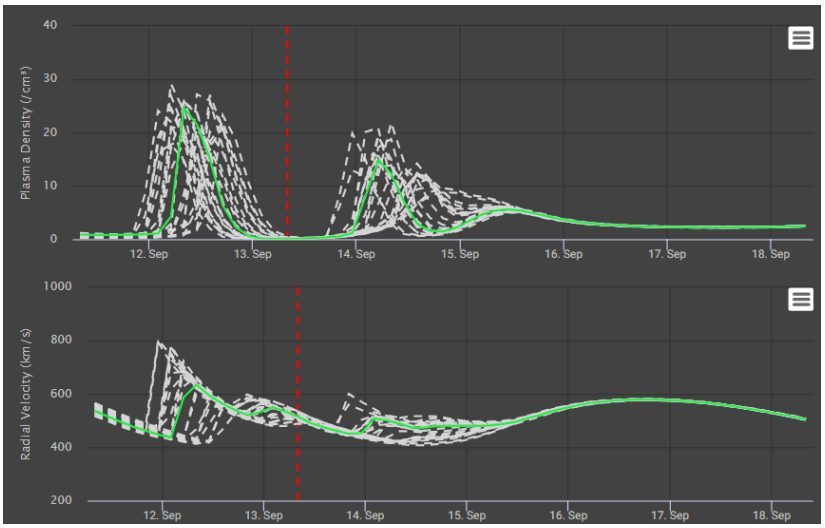
Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0657	Partial	M1.0 flare AR3814	N30 1E	709 km/s	14/0100 UTC +/- 9hrs	Weak, diffuse CME. Limited imagery

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 2a: Enlil and ensemble showing arrivals





Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Radio Blackouts - X-Ray Flares:

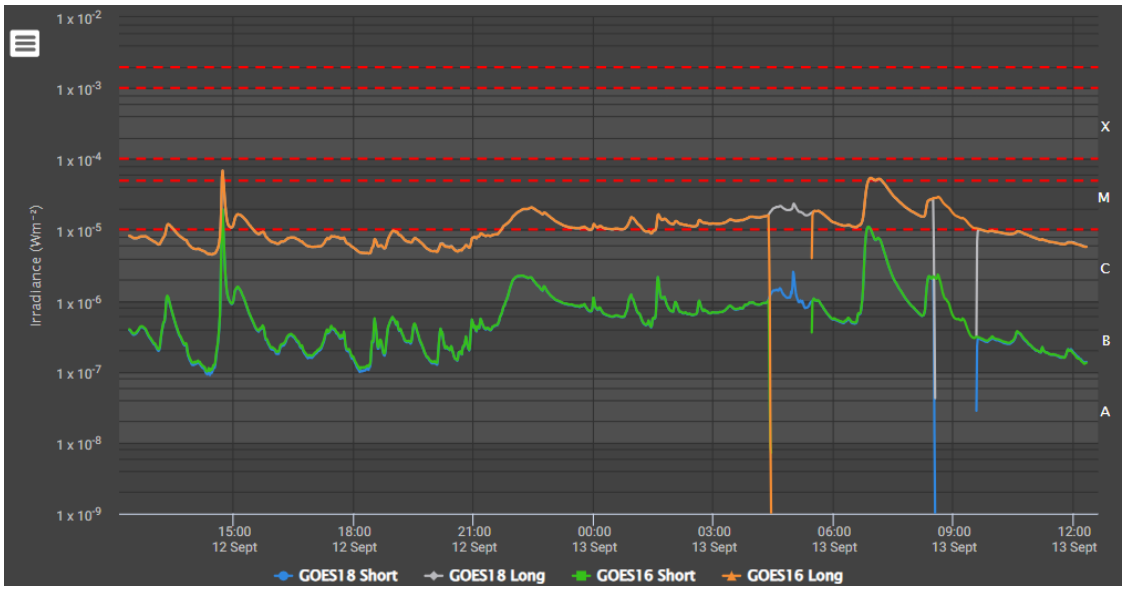
Moderate to High activity expected, with further M-flares expected, and a chance of X-class flares.

There are eight visible regions on the disc, however the most active region is currently just over the southwest limb, likely ex AR3811. This has recently produced an eruptive long period low M-flare, followed by a further double peaking M5 flare, and has a history of other greater than M5 flares. Significant looping remains evident on SDO aia-94, and this region is likely to produce further flares that may be visible from the near-side, albeit with a decreasing risk days 1-2 (13-14 Sep).

The other region of note is AR3825 region in the southeast. This was the source of the X1.3 flare on 12 Sep, however it remains hard to assess due to its proximity to the limb. Despite this complexity is becoming visible, with apparent growth of penumbral area as it moves further onto the disc. This also includes a risk of further significant flares. The other regions on the disc remain simple, with some sign of decay.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	75	70	70
Very Active	R3 to R5 X Class	No	25	20	10	10

Figure 3: GOES16-18 X-ray flux



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

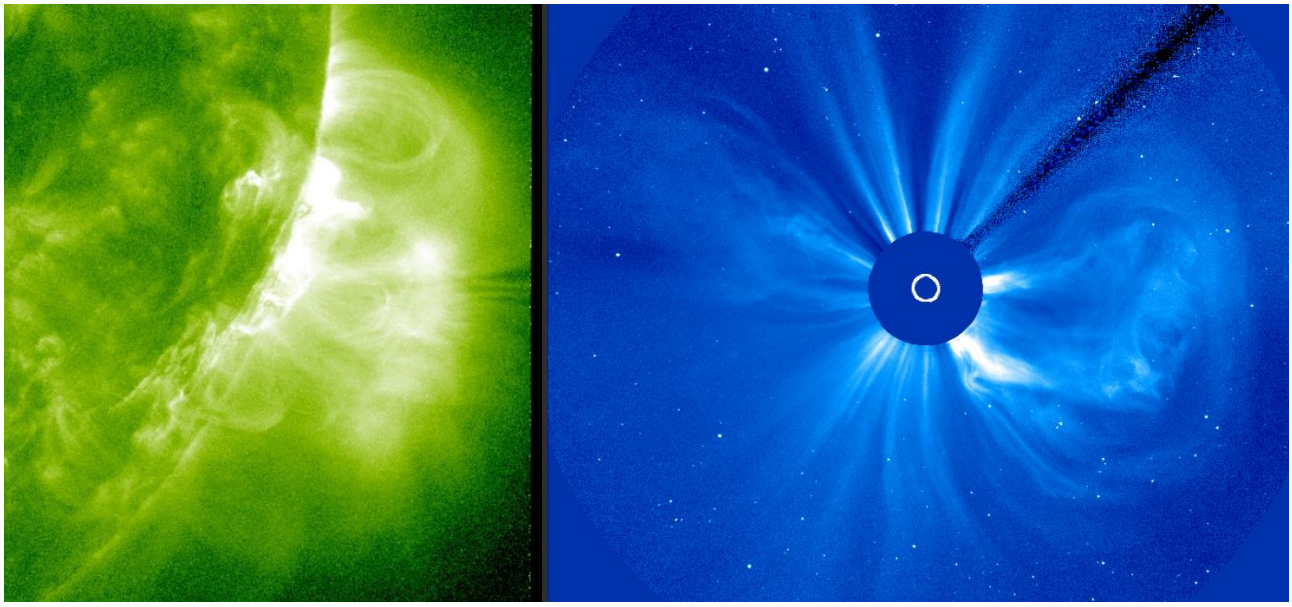
© Crown Copyright 2024. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

High energy protons, as observed by GOES-18, are currently at background. However recent eruptive events on the southwest limb, including a wide and bright off the Earth-Sun line CME have the potential to be proton rich, and well connect to the Earth. Although no enhancement has yet to be observed. Further events are possible from this region, before rotating further onto the far-side with any risk then declining.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	25	25	20	10
Very Active	**≥ S3 ***	No	5	5	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Significant looping on limb, and large CME that occurred likely from AR3811



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux is currently at background. Recent CME arrival will have suppress the observed counts at GEO, although some charging is likely to have occurred at lower orbits. With a further CME arrival anticipated later day 1 or early day 2 (13-14 Sep), and the potential for onset of coronal hole fast winds days 3-4 (15-16 Sep), any periods of Moderate flux at GEO are expected to be brief, with mainly Background flux persisting.

The associated 24-hour fluence is expected to remain below the Active level, as shown by the MOSWOC REFM, although the increasing trend that is indicated is not expected.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.